CLAIMS

1. A process for forming an aqueous polyurethane dispersion, the process comprising:

providing an isocyanate terminated prepolymer by reacting (i) at least one diisocyanate comprising α,α,α,α-tetramethylxylene diisocyanate, (ii) at least one difunctional polyol comprising polypropylene glycol, and (iii) at least one isocyanate reactive compound comprising an acid functional group and at least two isocyanate reactive groups selected from a hydroxy, a primary amino, a secondary amino, and combinations thereof;

neutralizing the isocyanate reactive compound (iii) with a neutralizing agent comprising an amine group;

reacting the isocyanate terminated prepolymer with at least one chain terminating agent;

dispersing the isocyanate terminated prepolymer in water; and

reacting the isocyanate terminated prepolymer with at least one chain extending agent comprising an organic diamine.

2. The process of claim 1 wherein a N/COOH molar ratio of amine in the neutralizing agent to acid functional group in the isocyanate reactive compound (iii) ranges from 0.5:1 to 1:1.

3. The process of claim 1 wherein the isocyanate terminated prepolymer comprises from 20 to 30% by weight of the at least one diisocyanate (i), from 65 to 75 % by weight of the at least one difunctional polyol (ii), and from 3 to 6 % by weight of the at least one isocyanate reactive compound (iii).

4. The process of claim 1 wherein the at least one diisocyanate (i) further comprises at least one diisocyanate selected from 3,5,5-trimethyl-1-isocyanato-3-isocyanatomethylcyclohexane isophorone diisocyanate (IPDI) and derivatives thereof, tetramethylene diisocyanate, hexamethylene diisocyanate (HDI) and derivatives thereof, 2,4-toluene diisocyanate, 2,6-toluene diisocyanate, isophorone diisocyanate, *m*-isopropenyl-α,α-dimethylbenzyl isocyanate (TMI), 4,4'dicyclohexylmethane diisocyante (H12MDI), benzene 1,3-bis (1-iscyanato-1-methylethyl), 1-5 naphthalene diisocyanate (NDI), *p*-phenylene diisocyanate (PPDI), *trans*-cyclohexane-1,4-diisocyanate (TMI),

bitolylene diisocyanate (TODI), 4,4'-diphenylmethane diisocyanate, 4,4'-diphenyl dimethyl methane diisocyanate, di- and tetraalkyl diphenyl methane diisocyanate, 4,4'-dibenzyl diisocyanate, 1,3-phenylene diisocyanate, 1,4-phenylene diisocyanate, the isomers of tolylene diisocyanate, 1-methyl-2,4-diisocyanatocyclohexane, 1,6-diisocyanato-2,2,4-trimethyl hexane, 1,6-diisocyanato-2,4,4 -trimethyl hexane, 1-isocyanatomethyl-3-isocyanatomethyl-3-isocyanato-1,5,5-trimethyl cyclohexane, chlorinated and brominated diisocyanates, phosphorus-containing diisocyanates, 4,4'-diisocyanatophenyl perfluoroethane, tetramethoxy butane-1,4-diisocyanate, butane-1,4-diisocyanate, hexane-1,6-diisocyanate, dicyclohexyl methane diisocyanate, cyclohexane-1,4-diisocyanate, ethylene diisocyanate, phthalic acid-bis-isocyanatoethyl ester, polyisocyanates containing reactive halogen atoms, sulfur-containing polyisocyanates, trimethyl hexamethylene diisocyanate, 1,4-diisocyanatobutane, 1,2-diisocyanatododecane, dimer fatty acid diisocyanate, partly masked polyisocyanates, and mixtures thereof.

5. The process of claim 1 wherein the at least one diisocyanate (i) comprises about 50% by weight or greater $\alpha,\alpha,\alpha,\alpha$-tetramethylxylene diisocyanate.

6. The process of claim 5 wherein the at least one diisocycanate (i) comprises about 80% by weight or greater $\alpha,\alpha,\alpha,\alpha$-tetramethylxylene diisocyanate.

7. The process of claim 1 wherein the at least one difunctional polyol (ii) has a weight average molecular weight that ranges from about 400 to about 6,000.

8. The process of claim 1 wherein the at least one difunctional polyol (ii) further comprises a polyol selected from polyethylene glycol (PEG), polypropylene glycol (PPO), polytetramethylene glycol (PTMEG), and mixtures thereof.

9. The process of claim 1 wherein the at least one difunctional polyol (ii) comprises about 75% by weight or greater polypropylene glycol having a weight average molecular weight of 2,000.

10. The process of claim 9 wherein the at least one difunctional polyol (ii) comprises about 95% by weight or greater polypropylene glycol having a weight average molecular weight of 2,000.

11. The process of claim 1 wherein the at least one isocyanate reactive compound (iii) is selected from dimethylolpropionic acid (DMPA), dimethylol butanioc acid (DMBA), and mixtures thereof.

12. The process of claim 1 wherein the neutralizing step is conducted during at least a portion of the first reacting step.

13. The process of claim 1 wherein the neutralizing step is conducted during at least a portion of the dispersing step.

14. The process of claim 1 wherein the second reacting step is conducted during at least a portion of the first reacting step.

15. A process for forming an aqueous polyurethane dispersion comprising a polyurethane polymer wherein the polyurethane polymer has a weight average molecular weight ranging from 20,000 to 80,000, the process comprising:

preparing a reaction mixture comprising (i) at least one diisocyanate comprising α,α,α,α-tetramethylxylene diisocyanate, (ii) at least one difunctional polyol comprising polypropylene glycol, (iii) at least one isocyanate reactive compound comprising an acid functional group and at least two isocyanate reactive groups selected from a hydroxy, a primary amino, a secondary amino, and combinations thereof, optionally (iv) a catalyst, and optionally (v) a solvent, wherein the weight percentage of free isocyanate groups contained within the reaction mixture ranges from about 1.6 to about 2.6 weight percent based upon solids;

adding a neutralizing agent comprising a tertiary amino group to the reaction mixture wherein the neutralizing agent is present in an amount sufficient to neutralize from about 50 to about 105 mole percent based upon solids of the acid functional group contained within the at least one isocyanate reactive compound (iii);

adding a chain terminating agent to the reaction mixture wherein the chain terminating agent is present in an amount sufficient to react with from about 2 to 50 mole percent of the remaining isocyanate groups contained therein to provide an isocyanate terminated prepolymer;

dispersing the isocyanate terminated prepolymer in water to provide an aqueous dispersion; and

adding a chain extending agent to the aqueous dispersion in an amount sufficient to react with about 80 to 105 mole percent of the remaining isocyanate groups contained therein to provide the aqueous polyurethane dispersion.

16. A process for forming an aqueous polyurethane dispersion comprising a polyurethane polymer wherein the polyurethane polymer has a weight average molecular weight ranging from 20,000 to 80,000, the process comprising:

preparing a isocyanate terminated prepolymer by reacting (i) at least one diisocyanate comprising α,α,α,α-tetramethylxylene diisocyanate, (ii) at least one difunctional polyol comprising polypropylene glycol, and (iii) at least one isocyanate reactive compound comprising an acid functional group and at least two isocyanate reactive groups selected from a hydroxy, a primary amino, a secondary amino, and combinations thereof;

contacting the isocyanate terminated prepolymer with a neutralizing agent comprising an amine group;

controlling the weight average molecular weight of the polyurethane polymer by reacting the isocyanate terminated prepolymer with at least one chain terminating agent; and/or maintaining a N/COOH molar ratio of amine in the neutralizing agent to acid functional group in the isocyanate reactive compound (iii) to from about 0.5:1 to about 1:1;

dispersing the isocyanate terminated prepolymer in water to provide an aqueous dispersion; and

adding a chain extending agent to the aqueous dispersion in an amount sufficient to react with at least a portion of the isocyanate groups contained therein to provide the aqueous polyurethane dispersion.

17. An aqueous polyurethane dispersion comprising a polyurethane polymer comprising the reaction product of:

(a) an isocyanate terminated prepolymer comprising the reaction product of (i) at least one polyisocyanate comprising α,α,α,α-tetramethylxylene diisocyanate, (ii) at least one difunctional polyol comprising polypropylene glycol, and (iii) an isocyanate reactive compound comprising an acid functional group and at least two isocyanate reactive groups selected from a hydroxy, a primary amino, a secondary amino, and combinations thereof;

(b) a neutralizing agent comprising a tertiary amino group;

(c) a monofunctional chain terminating agent;

(d) a chain extending agent comprising an organic diamine; and

(e) water.

18. The aqueous polyurethane dispersion of claim 17 wherein the polyurethane polymer has a weight average molecular weight ranging from 20,000 to 80,000

19. The aqueous polyurethane dispersion of claim 17 wherein the aqueous polyurethane dispersion when dried is substantially free of crystallinity as determined by differential scanning calorimetry.

20. The aqueous polyurethane dispersion of claim 17 wherein the aqueous polyurethane dispersion has a base volume resistivity ranging from 1×10^{10} to 1×10^{11} ohm-cm.

21. The aqueous polyurethane dispersion of claim 20 wherein the base volume resistivity is adjusted by adding at least one selected from an inorganic salt, an organic salt, or mixtures thereof.

22. A process for forming an aqueous polyurethane dispersion comprising a polyurethane polymer wherein the polyurethane polymer has a weight average molecular weight ranging from 20,000 to 80,000, the process comprising:

preparing a isocyanate terminated prepolymer by reacting (i) at least one diisocyanate comprising α,α,α,α-tetramethylxylene diisocyanate, (ii) at least one difunctional polyol comprising polypropylene glycol, and (iii) at least one isocyanate reactive compound comprising an acid functional group and at least two isocyanate reactive groups selected from a hydroxy, a primary amino, a secondary amino, and combinations thereof;

contacting the isocyanate terminated prepolymer with a neutralizing agent comprising an amine group;

controlling the weight average molecular weight of the polyurethane polymer by reacting the isocyanate terminated prepolymer with at least one chain terminating agent; and/or maintaining a N/COOH molar ratio of amine in the neutralizing agent to acid functional group in the isocyanate reactive compound (iii) to from about 0.5:1 to about 1:1;

dispersing the isocyanate terminated prepolymer in water to provide an aqueous dispersion; and

adding a chain extending agent to the aqueous dispersion in an amount sufficient to react with at least a portion of the isocyanate groups contained therein to provide the aqueous polyurethane dispersion.

23. An aqueous polyurethane dispersion comprising:

(A) a polyurethane polymer comprising the reaction product of:

(a) an isocyanate terminated prepolymer comprising the reaction product of (i) at least one polyisocyanate comprising α,α,α,α-tetramethylxylene diisocyanate, (ii) at least one difunctional polyol comprising polypropylene glycol, and (iii) an isocyanate reactive compound comprising an acid functional group and at least two isocyanate reactive groups selected from a hydroxy, a primary amino, a secondary amino, and combinations thereof;

(b) a neutralizing agent comprising an amine;

(c) a chain terminating agent;

(d) a chain extending agent comprising an organic diamine; and

(e) water; and

(B) at least one ionic additive selected from an inorganic salt, an organic salt, and combinations thereof.

24. The aqueous polyurethane dispersion of claim 23 wherein the at least one ionic additive is an inorganic salt selected from the group consisting of $LiCF_3SOF_3$, $LiClO_4$, $LiPF_6$, $LiBF_4$, $LiAsF_6$, $LiN(CF_3SO_2)_3$, and mixtures thereof.